Table of Contents

| ACK | NOWLEDGMENTS | I |
|--------|--|-------|
| TAB | LE OF CONTENTS | III |
| LIST | OF TABLES, FIGURES, AND BOXES | VI |
| Tables | S | vi |
| Figure | es es | vi |
| Boxes | | xiii |
| EXE | CUTIVE SUMMARY | ES-1 |
| ES.1. | Background Information | ES-1 |
| ES.2. | Recent Trends in U.S. Greenhouse Gas Emissions and Sinks | ES-3 |
| ES.3. | Overview of Source and Sink Emission Trends | ES-7 |
| ES.4. | Other Information | ES-20 |
| 1. | INTRODUCTION | 1 |
| 1.1. | Background Information | 2 |
| 1.2. | Institutional Arrangements | 10 |
| 1.3. | Inventory Process | 10 |
| 1.4. | Methodology and Data Sources | 12 |
| 1.5. | Key Sources | 13 |
| 1.6. | Quality Assurance and Quality Control | 16 |
| 1.7. | Uncertainty and Limitations of Emission Estimates | 17 |
| 1.8. | Completeness | 18 |
| 1.9. | Organization of Report | 18 |
| 2. | TRENDS IN GREENHOUSE GAS EMISSIONS | 21 |
| 2.1. | Recent Trends in U.S. Greenhouse Gas Emissions | 21 |
| 2.2. | Emissions by Economic Sector | 28 |
| 2.3. | Ambient Air Pollutant Emissions | 34 |
| 3. | ENERGY | 37 |
| 3.1. | Carbon Dioxide Emissions from Fossil Fuel Combustion (IPCC Source Category 1A) | 38 |
| 3.2. | Carbon Stored in Products from Non-Energy Uses of Fossil Fuels (IPCC Source Category 1A) | 55 |
| 3.3. | Stationary Combustion (excluding CO ₂) (IPCC Source Category 1A) | 59 |
| 3.4. | Mobile Combustion (excluding CO ₂) (IPCC Source Category 1A) | 66 |
| 3.5. | Coal Mining (IPCC Source Category 1B1a) | 77 |
| 3.6. | Abandoned Underground Coal Mines (IPCC Source Category 1B1a) | 81 |
| 37 | Petroleum Systems (IPCC Source Category 182a) | 85 |

| 3.8. | Natural Gas Systems (IPCC Source Category 1B2b) | 87 |
|------------|---|-----------------|
| 3.9. | Municipal Solid Waste Combustion (IPCC Source Category 1A5) | 90 |
| 3.10. C | Natural Gas Flaring and Ambient Air Pollutant Emissions from Oil and Gas Activities (ategory 1B2) | (IPCC Source 95 |
| 3.11. | International Bunker Fuels (IPCC Source Category 1: Memo Items) | 97 |
| 3.12. | Wood Biomass and Ethanol Consumption (IPCC Source Category 1A) | 102 |
| 4. | INDUSTRIAL PROCESSES | 107 |
| 4.1. | Iron and Steel Production (IPCC Source Category 2C1) | 109 |
| 4.2. | Cement Manufacture (IPCC Source Category 2A1) | 113 |
| 4.3. | Ammonia Manufacture and Urea Application (IPCC Source Category 2B1) | 115 |
| 4.4. | Lime Manufacture (IPCC Source Category 2A2) | 120 |
| 4.5. | Limestone and Dolomite Use (IPCC Source Category 2A3) | 124 |
| 4.6. | Soda Ash Manufacture and Consumption (IPCC Source Category 2A4) | 127 |
| 4.7. | Titanium Dioxide Production (IPCC Source Category 2B5) | 129 |
| 4.8. | Phosphoric Acid Production (IPCC Source Category 2A7) | 131 |
| 4.9. | Ferroalloy Production (IPCC Source Category 2C2) | 135 |
| 4.10. | Carbon Dioxide Consumption (IPCC Source Category 2B5) | 137 |
| 4.11. | Petrochemical Production (IPCC Source Category 2B5) | 140 |
| 4.12. | Silicon Carbide Production (IPCC Source Category 2B4) | 142 |
| 4.13. | Nitric Acid Production (IPCC Source Category 2B2) | 143 |
| 4.14. | Adipic Acid Production (IPCC Source Category 2B3) | 145 |
| 4.15. | Substitution of Ozone Depleting Substances (IPCC Source Category 2F) | 147 |
| 4.16. | HCFC-22 Production (IPCC Source Category 2E1) | 150 |
| 4.17. | Electrical Transmission and Distribution (IPCC Source Category 2F7) | 151 |
| 4.18. | Aluminum Production (IPCC Source Category 2C3) | 155 |
| 4.19. | Semiconductor Manufacture (IPCC Source Category 2F6) | 159 |
| 4.20. | Magnesium Production and Processing (IPCC Source Category 2C4) | 162 |
| 4.21. | Industrial Sources of Ambient Air Pollutants | 166 |
| 5. | SOLVENT AND OTHER PRODUCT USE | 169 |
| 5.1. | Nitrous Oxide Product Usage (IPCC Source Category 3D) | 169 |
| 5.2. | Ambient Air Pollutants from Solvent Use | 172 |
| 6. | AGRICULTURE | 175 |
| 6.1. | Enteric Fermentation (IPCC Source Category 4A) | 176 |
| 6.2. | Manure Management (IPCC Source Category 4B) | 179 |
| 6.3. | Rice Cultivation (IPCC Source Category 4C) | 187 |
| 6.4. | Agricultural Soil Management (IPCC Source Category 4D) | 192 |

| 6.5. | Field Burning of Agricultural Residues (IPCC Source Category 4F) | 198 |
|------|--|-----|
| 7. | LAND-USE CHANGE AND FORESTRY | 205 |
| 7.1. | Changes in Forest Carbon Stocks (IPCC Source Category 5A) | 206 |
| 7.2. | Changes in Carbon Stocks in Urban Trees (IPCC Source Category 5A5) | 214 |
| 7.3. | Changes in Agricultural Soil Carbon Stocks (IPCC Source Category 5D) | 217 |
| 7.4. | Changes in Yard Trimming and Food Scrap Carbon Stocks in Landfills (IPCC Source Category 5E) | 224 |
| 8. | WASTE | 229 |
| 8.1. | Landfills (IPCC Source Category 6A1) | 229 |
| 8.2. | Wastewater Treatment (IPCC Source Category 6B) | 233 |
| 8.3. | Human Sewage (Domestic Wastewater) (IPCC Source Category 6B) | 236 |
| 8.4. | Waste Sources of Ambient Air Pollutants | 239 |
| 9. | OTHER | 241 |
| 10. | RECALCULATIONS AND IMPROVEMENTS | 243 |
| REF | ERENCES | 247 |

List of Tables, Figures, and Boxes

Tables

| Table ES-1: Global Warming Potentials (100 Year Time Horizon) Used in this Report | ES-3 |
|--|--|
| Table ES-2: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks (Tg CO ₂ Eq.) | ES-4 |
| Table ES-3: Annual Change in CO_2 Emissions from Fossil Fuel Combustion for Selected Fue CO_2 Eq. and Percent) | els and Sectors (Tg ES-6 |
| Table ES-4: U.S. Sources of CO ₂ Emissions and Sinks (Tg CO ₂ Eq.) | ES-7 |
| Table ES-5: CO ₂ Emissions from Fossil Fuel Combustion by End-Use Sector (Tg CO ₂ Eq.) | ES-9 |
| Table ES-6: U.S. Sources of CH ₄ Emissions (Tg CO ₂ Eq.) | ES-13 |
| Table ES-7: U.S. Sources of Nitrous Oxide Emissions (Tg CO ₂ Eq.) | ES-16 |
| Table ES-8: Emissions of HFCs, PFCs, and SF ₆ (Tg CO ₂ Eq.) | ES-18 |
| Table ES-9: Emissions of Ozone Depleting Substances (Gg) | ES-20 |
| Table ES-10: U.S. Greenhouse Gas Emissions Allocated to Economic Sectors (Tg ${\rm CO_2}$ Eq.) | ES-21 |
| Table ES-11: U.S Greenhouse Gas Emissions by Economic Sector and Gas with Electricity-Distributed (Tg $\rm CO_2$ Eq.) | Related Emissions ES-22 |
| Table ES-12: Recent Trends in Various U.S. Data (Index 1990 = 100) and Global Atmosphe | ric CO ₂ Concentration ES-22 |
| Table ES-13: Emissions of NO _x , CO, NMVOCs, and SO ₂ (Gg) | ES-23 |
| Table 1-1: Global atmospheric concentration (ppm unless otherwise specified), rate of conce (ppb/year) and atmospheric lifetime (years) of selected greenhouse gases | entration change |
| Table 1-2: Global Warming Potentials and Atmospheric Lifetimes (Years) Used in this Repo | ort 7 |
| Table 1-3: Comparison of 100 Year GWPs | 8 |
| Table 1-4: Effects on U.S. Greenhouse Gas Emission Trends Using IPCC SAR and TAR GV Eq.) | WP Values (Tg CO ₂ 9 |
| Table 1-5: Comparison of Emissions by Sector using IPCC SAR and TAR GWP Values (Tg | CO ₂ Eq.) 9 |
| Table 1-6: Key Source Categories for the United States (1990-2002) Based on Tier 1 Approach | ach 15 |
| Table 1-7: IPCC Sector Descriptions | 18 |
| Table 1-8: List of Annexes | 19 |
| Table 2-1: Annual Change in CO ₂ Emissions from Fossil Fuel Combustion for Selected Fuel Eq. and Percent) | s and Sectors (Tg CO ₂ 22 |
| Table 2-2: Recent Trends in Various U.S. Data (Index 1990 = 100) and Global Atmospheric | CO ₂ Concentration 24 |
| Table 2-3: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks (Tg CO ₂ Eq.) | 24 |
| Table 2-4: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks (Gg) | 26 |
| Table 2-5: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks by Chapter/IPCC Se | ctor (Tg CO ₂ Eq.) 27 |
| Table 2-6: U.S. Greenhouse Gas Emissions Allocated to Economic Sectors (Tg ${\rm CO_2}$ Eq. and 2002) | Percent of Total in 28 |
| Table 2-7: Electricity Generation-Related Greenhouse Gas Emissions (Tg CO ₂ Eq.) | 30 |

| Table 2-8: U.S Greenhouse Gas Emissions by "Economic Sector" and Gas with Electricity-Related Em Distributed (Tg CO ₂ Eq.) and percent of total in 2002 | issions 31 |
|--|---------------------------|
| Table 2-9: Transportation-Related Greenhouse Gas Emissions (Tg CO ₂ Eq.) | 33 |
| Table 2-10: Emissions of NO _x , CO, NMVOCs, and SO ₂ (Gg) | 35 |
| Table 3-1: Emissions from Energy (Tg CO ₂ Eq.) | 37 |
| Table 3-2: Emissions from Energy (Gg) | 38 |
| Table 3-3: CO ₂ Emissions from Fossil Fuel Combustion by Fuel Type and Sector (Tg CO ₂ Eq.) | 39 |
| Table 3-4: Fossil Fuel Carbon in Products (Tg CO ₂ Eq.)* | 41 |
| Table 3-5: CO ₂ Emissions from International Bunker Fuels (Tg CO ₂ Eq.)* | 42 |
| Table 3-6: CO ₂ Emissions from Fossil Fuel Combustion by End-Use Sector (Tg CO ₂ Eq.) | 42 |
| Table 3-7: CO ₂ Emissions from Fossil Fuel Combustion in Transportation End-Use Sector (Tg CO ₂ Eq. | .) 43 |
| Table 3-8: Carbon Intensity from Direct Fossil Fuel Combustion by Sector (Tg CO ₂ Eq./QBtu) | 48 |
| Table 3-9: Carbon Intensity from all Energy Consumption by Sector (Tg CO ₂ Eq./QBtu) | 49 |
| Table 3-10: Uncertainty Estimates for CO ₂ from Fossil Fuel Combustion by Fuel Type and Sector | 53 |
| Table 3-11: 2002 Non-Energy Use (NEU) Fossil Fuel Consumption, Storage, and Emissions | 55 |
| Table 3-12: Storage and Emissions from NEU Fossil Fuel Consumption (Tg CO ₂ Eq.) | 56 |
| Table 3-13: Quantitative Uncertainty Estimates for Carbon Stored in Products (Tg C) and Carbon Stora (Percent) | ge Factor 58 |
| Table 3-14: CH ₄ Emissions from Stationary Combustion (Tg CO ₂ Eq.) | 60 |
| Table 3-15: N ₂ O Emissions from Stationary Combustion (Tg CO ₂ Eq.) | 61 |
| Table 3-16: CH ₄ Emissions from Stationary Combustion (Gg) | 61 |
| Table 3-17: N ₂ O Emissions from Stationary Combustion (Gg) | 62 |
| Table 3-18: NO _x , CO, and NMVOC Emissions from Stationary Combustion in 2002 (Gg) | 62 |
| Table 3-19: Quantitative Uncertainty Estimates for CH_4 and N_2O Emissions from Stationary Combustic Biomass (Tg CO_2 Eq. and Percent) | on, Including 65 |
| Table 3-20: CH ₄ Emissions from Mobile Combustion (Tg CO ₂ Eq.) | 67 |
| Table 3-21: N ₂ O Emissions from Mobile Combustion (Tg CO ₂ Eq.) | 67 |
| Table 3-22: CH ₄ Emissions from Mobile Combustion (Gg) | 67 |
| Table 3-23: N ₂ O Emissions from Mobile Combustion (Gg) | 68 |
| Table 3-24: NO _x Emissions from Mobile Combustion (Gg) | 68 |
| Table 3-25: CO Emissions from Mobile Combustion (Gg) | 69 |
| Table 3-26: NMVOC Emissions from Mobile Combustion (Gg) | 69 |
| Table 3-27: Quantitative Uncertainty Estimates for CH_4 and N_2O Emissions from Highway Vehicles (T and Percent) | Tg CO ₂ Eq. 76 |
| Table 3-28: CH ₄ Emissions from Coal Mining (Tg CO ₂ Eq.) | 78 |
| Table 3-29: CH ₄ Emissions from Coal Mining (Gg) | 78 |
| Table 3-30: Coal Production (Thousand Metric Tons) | 79 |
| Table 3-31: Quantitative Uncertainty Estimates for CH ₄ Emissions from Coal Mining (Tg CO ₂ Eq. and | Percent) 80 |

| Table 3-32: | CH ₄ Emissions from Abandoned Coal Mines (Tg CO ₂ Eq.) | 81 |
|-----------------------|--|--------------------------|
| Table 3-33: | CH ₄ Emissions from Abandoned Coal Mines (Gg) | 81 |
| | Range of Uncertainty Estimates for CH ₄ Emissions from Abandoned Underground Coal Mining (q. and Percent) | Tg 84 |
| Table 3-35: | CH ₄ Emissions from Petroleum Systems (Tg CO ₂ Eq.) | 85 |
| Table 3-36: | CH ₄ Emissions from Petroleum Systems (Gg) | 85 |
| Table 3-37: | Range of Uncertainty Estimates for CH ₄ Emissions from Petroleum Systems (Tg CO ₂ Eq. and Per | cent) 87 |
| Table 3-38: | CH ₄ Emissions from Natural Gas Systems (Tg CO ₂ Eq.) | 88 |
| Table 3-39: | CH ₄ Emissions from Natural Gas Systems (Gg) | 89 |
| Table 3-40: Percen | Range of Uncertainty Estimates for CH ₄ Emissions from Natural Gas Systems (Tg CO ₂ Eq. and t) | 89 |
| Table 3-41: | CO ₂ and N ₂ O Emissions from Municipal Solid Waste Combustion (Tg CO ₂ Eq.) | 91 |
| Table 3-42: | CO ₂ and N ₂ O Emissions from Municipal Solid Waste Combustion (Gg) | 91 |
| Table 3-43: | NO _x , CO, and NMVOC Emissions from Municipal Solid Waste Combustion (Gg) | 91 |
| Table 3-44: | Municipal Solid Waste Generation (Metric Tons) and Percent Combusted | 92 |
| Table 3-45: Percen | Range of Uncertainty Estimates for CO ₂ from Municipal Solid Waste Combustion (Tg CO ₂ Eq. at t) | nd 93 |
| Table 3-46: | U.S. Municipal Solid Waste Combusted, as Reported by EPA and BioCycle (Metric Tons) | 93 |
| Table 3-47: | CO ₂ Emissions from On-Shore and Off-Shore Natural Gas Flaring (Tg CO ₂ Eq.) | 95 |
| Table 3-48: | CO ₂ Emissions from On-Shore and Off-Shore Natural Gas Flaring (Gg) | 96 |
| Table 3-49: | NO _x , NMVOCs, and CO Emissions from Oil and Gas Activities (Gg) | 96 |
| Table 3-50: | Volume Flared Offshore (MMcf) and Fraction Vented and Flared (Percent) | 96 |
| Table 3-51: | Total Natural Gas Reported Vented and Flared (Million Ft ³) and Thermal Conversion Factor (Btu | /Ft ³) 97 |
| Table 3-52: | Emissions from International Bunker Fuels (Tg CO ₂ Eq.) | 99 |
| Table 3-53: | Emissions from International Bunker Fuels (Gg) | 99 |
| Table 3-54: | Aviation Jet Fuel Consumption for International Transport (Million Gallons) | 100 |
| Table 3-55: | Marine Fuel Consumption for International Transport (Million Gallons) | 101 |
| Table 3-56: | CO ₂ Emissions from Wood Consumption by End-Use Sector (Tg CO ₂ Eq.) | 103 |
| Table 3-57: | CO ₂ Emissions from Wood Consumption by End-Use Sector (Gg) | 103 |
| Table 3-58: | CO ₂ Emissions from Ethanol Consumption | 103 |
| Table 3-59: | Woody Biomass Consumption by Sector (Trillion Btu) | 104 |
| Table 3-60: | Ethanol Consumption | 104 |
| Table 3-61: | CH ₄ Emissions from Non-Combustion Fossil Sources (Gg) | 105 |
| Table 3-62: | Formation of CO ₂ through Atmospheric CH ₄ Oxidation (Tg CO ₂ Eq.) | 106 |
| Table 4-1: | Emissions from Industrial Processes (Tg CO ₂ Eq.) | 107 |
| Table 4-2: | Emissions from Industrial Processes (Gg) | 108 |

| Table 4-3: | CO ₂ and CH ₄ Emissions from Iron and Steel Production (Tg CO ₂ Eq.) | 110 |
|-----------------------|--|------------|
| Table 4-4: | CO ₂ and CH ₄ Emissions from Iron and Steel Production (Gg) | 110 |
| Table 4-5: | CH ₄ Emission Factors for Coal Coke, Sinter, and Pig Iron Production | 111 |
| | Production and Consumption Data for the Calculation of CO ₂ and CH ₄ Emissions from Iron and Stection (Thousand Metric Tons) | el 111 |
| | Quantitative Uncertainty Estimates for CO ₂ and CH ₄ Emissions from Iron and Steel Production (Tg. q. and Percent) | 113 |
| Table 4-8: | CO ₂ Emissions from Cement Production* | 113 |
| Table 4-9: | Cement Production (Gg) | 115 |
| Table 4-10: Percen | Quantitative Uncertainty Estimates for CO ₂ Emissions from Cement Manufacture (Tg CO ₂ Eq. and at) | l 115 |
| Table 4-11: | CO ₂ Emissions from Ammonia Manufacture | 116 |
| Table 4-12: | CO ₂ Emissions from Urea Application | 116 |
| Table 4-13: | Ammonia Production | 117 |
| Table 4-14: | Urea Production | 118 |
| Table 4-15: | Urea Net Imports | 118 |
| | Quantitative Uncertainty Estimates for CO ₂ Emissions from Ammonia Manufacture and Urea ration (Tg CO ₂ Eq. and Percent) | 119 |
| Table 4-17: | Net CO ₂ Emissions from Lime Manufacture | 120 |
| Table 4-18: | CO ₂ Emissions from Lime Manufacture (Gg) | 120 |
| Table 4-19: | Lime Production and Lime Use for Sugar Refining and PCC (Thousand Metric Tons) | 122 |
| Table 4-20: | Hydrated Lime Production (Thousand Metric Tons) | 122 |
| Table 4-21: Percen | Quantitative Uncertainty Estimates for CO ₂ Emissions from Lime Manufacture (Tg CO ₂ Eq. and tt) | 123 |
| Table 4-22: | CO ₂ Emissions from Limestone & Dolomite Use (Tg CO ₂ Eq.) | 124 |
| Table 4-23: | CO ₂ Emissions from Limestone & Dolomite Use (Gg) | 124 |
| Table 4-24: | Limestone and Dolomite Consumption (Thousand Metric Tons) | 125 |
| Table 4-25: | Dolomitic Magnesium Metal Production Capacity (Metric Tons) | 126 |
| Table 4-26: and Pe | Quantitative Uncertainty Estimates for CO ₂ Emissions from Limestone and Dolomite Use (Tg CO ₂ creent) | Eq. 126 |
| Table 4-27: | CO ₂ Emissions from Soda Ash Manufacture and Consumption | 127 |
| Table 4-28: | CO ₂ Emissions from Soda Ash Manufacture and Consumption (Gg) | 127 |
| Table 4-29: | Soda Ash Manufacture and Consumption (Thousand Metric Tons) | 128 |
| | Quantitative Uncertainty Estimates for CO_2 Emissions from Soda Ash Manufacture and Consumpt O_2 Eq. and Percent) | ion 129 |
| Table 4-31: | CO ₂ Emissions from Titanium Dioxide | 130 |
| Table 4-32: | Titanium Dioxide Production | 130 |
| Table 4-33: | Quantitative Uncertainty Estimates for CO ₂ Emissions from Titanium Dioxide Production (Tg CO ₂ | Eq |

| Table 4-34: | CO ₂ Emissions from Phosphoric Acid Production | 132 |
|------------------------|--|-----------------------|
| Table 4-35: | Phosphate Rock Domestic Production, Exports, and Imports (Thousand Metric Tons) | 133 |
| Table 4-36: | Chemical Composition of Phosphate Rock (percent by weight) | 133 |
| Table 4-37: and Per | Quantitative Uncertainty Estimates for CO ₂ Emissions from Phosphoric Acid Production (Tg CO ₂ reent) | Eq. 134 |
| Table 4-38: | CO ₂ Emissions from Ferroalloy Production | 135 |
| Table 4-39: | Production of Ferroalloys (Metric Tons) | 136 |
| Table 4-40: Percen | Quantitative Uncertainty Estimates for CO ₂ Emissions from Ferroalloy Production (Tg CO ₂ Eq. art) | nd 137 |
| Table 4-41: | CO ₂ Emissions from Carbon Dioxide Consumption | 138 |
| Table 4-42: | Carbon Dioxide Consumption | 138 |
| | Quantitative Uncertainty Estimates for CO ₂ Emissions from Carbon Dioxide Consumption (Tg CO d Percent) |) ₂ 139 |
| Table 4-44: | CH ₄ Emissions from Petrochemical Production | 140 |
| Table 4-45: | Production of Selected Petrochemicals (Thousand Metric Tons) | 141 |
| Table 4-46: Percen | Quantitative Uncertainty Estimates for CH ₄ Emissions from Petrochemical Production (Tg CO ₂ Ect) | q. and 141 |
| Table 4-47: | CH ₄ Emissions from Silicon Carbide Production | 142 |
| Table 4-48: | Production of Silicon Carbide | 142 |
| Table 4-49: | N ₂ O Emissions from Nitric Acid Production | 143 |
| Table 4-50: | Nitric Acid Production | 144 |
| Table 4-51: Percent | Quantitative Uncertainty Estimates for N ₂ O Emissions from Nitric Acid Production (Tg CO ₂ Eq. at) | nd 144 |
| Table 4-52: | N ₂ O Emissions from Adipic Acid Production | 145 |
| Table 4-53: | Adipic Acid Production | 146 |
| Table 4-54: Percent | Quantitative Uncertainty Estimates for N_2O Emissions from Adipic Acid Production (Tg CO_2 Eq. t) | and 147 |
| Table 4-55: | Emissions of HFCs and PFCs from ODS Substitution (Tg CO ₂ Eq.) | 148 |
| Table 4-56: | Emissions of HFCs and PFCs from ODS Substitution (Mg) | 148 |
| Table 4-57: and Per | Quantitative Uncertainty Estimates for HFC and PFC Emissions from ODS Substitution (Tg CO ₂ Ircent) | Eq. 149 |
| Table 4-58: | HFC-23 Emissions from HCFC-22 Production | 150 |
| Table 4-59: | HCFC-22 Production | 151 |
| Table 4-60: Percen | Quantitative Uncertainty Estimates for HFC-23 Emissions from HCFC-22 Production (Tg CO ₂ Eqt) | ı. and 151 |
| Table 4-61: | SF_6 Emissions from Electric Power Systems and Original Equipment Manufactures (Tg CO_2 Eq.) | 152 |
| Table 4-62: | SF ₆ Emissions from Electric Power Systems and Original Equipment Manufactures (Gg) | 152 |
| | Quantitative Uncertainty Estimates for SF_6 Emissions from Electrical Transmission and Distribution Eq. (2) Eq. and Percent) | on 154 |
| Table 4-64: | CO ₂ Emissions from Aluminum Production | 155 |

| Table 4-65: PFC Emissions from Aluminum Production (Tg CO ₂ Eq.) | 156 |
|--|---------------------------|
| Table 4-66: PFC Emissions from Aluminum Production (Gg) | 156 |
| Table 4-67: Production of Primary Aluminum | 158 |
| Table 4-68: Quantitative Uncertainty Estimates for CO ₂ Emissions from Aluminum Production (Tg CO ₂ Eq.) | 158 |
| Table 4-69: Quantitative Uncertainty Estimates for PFC Emissions from Aluminum Production (Tg CO ₂ Eq. a Percent) | ind 159 |
| Table 4-70: PFC, HFC, and SF ₆ Emissions from Semiconductor Manufacture (Tg CO ₂ Eq.) | 160 |
| Table 4-71: PFC, HFC, and SF ₆ Emissions from Semiconductor Manufacture (Mg) | 160 |
| Table 4-72: Quantitative Uncertainty Estimates for HFC, PFC, and SF ₆ Emissions from Semiconductor Manufacture (Tg CO ₂ Eq. and Percent) | 162 |
| Table 4-73: SF ₆ Emissions from Magnesium Production and Processing | 162 |
| Table 4-74: SF ₆ Emission Factors (kg SF ₆ per metric ton of magnesium) | 163 |
| Table 4-75: Quantitative Uncertainty Estimates for SF ₆ Emissions from Magnesium Production and Processin CO ₂ Eq. and Percent) | g (Tg 164 |
| Table 4-76: 2002 Potential and Actual Emissions of HFCs, PFCs, and SF ₆ from Selected Sources (Tg CO ₂ Eq | .)166 |
| Table 4-77: NO _x , CO, and NMVOC Emissions from Industrial Processes (Gg) | 166 |
| Table 5-1: N ₂ O Emissions from Solvent and Other Product Use | 169 |
| Table 5-2: N ₂ O Emissions from Nitrous Oxide Product Usage | 169 |
| Table 5-3: N ₂ O Production (Thousand Metric Tons) | 170 |
| Table 5-4: Quantitative Uncertainty Estimates for N ₂ O Emissions from Nitrous Oxide Product Usage (Tg CO ₂ and Percent) | Eq. 171 |
| Table 5-5: Emissions of NO _x , CO, and NMVOC from Solvent Use (Gg) | 172 |
| Table 6-1: Emissions from Agriculture (Tg CO ₂ Eq.) | 175 |
| Table 6-2: Emissions from Agriculture (Gg) | 175 |
| Table 6-3: CH ₄ Emissions from Enteric Fermentation (Tg CO ₂ Eq.) | 176 |
| Table 6-4: CH ₄ Emissions from Enteric Fermentation (Gg) | 176 |
| Table 6-5: Quantitative Uncertainty Estimates for CH ₄ Emissions from Enteric Fermentation (Tg CO ₂ Eq. and Percent) | l 179 |
| Table 6-6: CH ₄ and N ₂ O Emissions from Manure Management (Tg CO ₂ Eq.) | 181 |
| Table 6-7: CH ₄ and N ₂ O Emissions from Manure Management (Gg) | 181 |
| Table 6-8: Quantitative Uncertainty Estimates for CH ₄ and N ₂ O Emissions from Manure Management (Tg CC and %) | D ₂ Eq. 184 |
| Table 6-9: CH ₄ Emissions from Rice Cultivation (Tg CO ₂ Eq.) | 188 |
| Table 6-10: CH ₄ Emissions from Rice Cultivation (Gg CH ₄) | 189 |
| Table 6-11: Rice Areas Harvested (Hectares) | 190 |
| Table 6-12: Quantitative Uncertainty Estimates for CH ₄ Emissions from Rice Cultivation (Tg CO ₂ Eq. and Per | rcent) 191 |
| Table 6-13: N ₂ O Emissions from Agricultural Soil Management (Tg CO ₂ Eq.) | 192 |
| Table 6-14: N ₂ O Emissions from Agricultural Soil Management (Gg N ₂ O) | 193 |

| Table 6-15: Direct N ₂ O Emissions from Managed Soils (Tg CO ₂ Eq.) | 193 |
|---|---------------------------|
| Table 6-16: Direct N ₂ O Emissions from Pasture, Range, and Paddock Livestock Manure (Tg CO ₂ Eq.) | 193 |
| Table 6-17: Indirect N ₂ O Emissions (Tg CO ₂ Eq.) | 193 |
| Table 6-18: Quantitative Uncertainty Estimates of N_2O Emissions from Agricultural Soil Management (Tg O and Percent) | CO ₂ Eq 197 |
| Table 6-19: Emissions from Field Burning of Agricultural Residues (Tg CO ₂ Eq.) | 199 |
| Table 6-20: Emissions from Field Burning of Agricultural Residues (Gg)* | 199 |
| Table 6-21: Agricultural Crop Production (Thousand Metric Tons of Product) | 201 |
| Table 6-22: Percentage of Rice Area Burned by State | 201 |
| Table 6-23: Percentage of Rice Area Burned in California | 202 |
| Table 6-24: Key Assumptions for Estimating Emissions from Agricultural Residue Burning | 202 |
| Table 6-25: Greenhouse Gas Emission Ratios | 202 |
| Table 6-26: Quantitative Uncertainty Estimates for CH_4 and N_2O Emissions from Field Burning of Agricultu Residues (Tg CO_2 Eq. and Percent) | ıral 203 |
| Table 7-1: Net CO ₂ Flux from Land-Use Change and Forestry (Tg CO ₂ Eq.) | 206 |
| Table 7-2: Net CO ₂ Flux from Land-Use Change and Forestry (Tg C) | 206 |
| Table 7-3: Net Changes in Carbon Stocks in Forest and Harvested Wood Pools, and Total Net Forest Carbon (Tg CO ₂ Eq.) | Flux 208 |
| Table 7-4: Net Changes in Carbon Stocks in Forest and Harvested Wood Pools, and Total Net Forest Carbon (Tg C) | Flux 208 |
| Table 7-5: Carbon Stocks in Forest and Harvested Wood Pools (Tg C) | 209 |
| Table 7-6: Carbon Stocks in Forest Soils (Tg C) | 209 |
| Table 7-7: Net Flux from Urban Trees (Tg CO ₂ Eq. and Tg C) | 214 |
| Table 7-8: Carbon Stocks (Metric Tons C), Annual Carbon Sequestration (Metric Tons C/yr), Tree Cover (Peand Annual Carbon Sequestration per Area of Tree Cover (kg C/m² cover-yr) for Ten U.S. Cities | ercent) 216 |
| Table 7-9: Quantitative Uncertainty Estimates for CO ₂ Emissions from Changes in Carbon Stocks in Urban 7 (Tg CO ₂ Eq. and Percent) | Trees 216 |
| Table 7-10: Net CO ₂ Flux from Agricultural Soils (Tg CO ₂ Eq.) | 218 |
| Table 7-11: Net Carbon Flux from Agricultural Soils (Tg C) | 218 |
| Table 7-12: Quantities of Applied Minerals (Thousand Metric Tons) | 221 |
| Table 7-13: Quantitative Uncertainty Estimates for CO_2 Flux from Agricultural Soil Carbon Stocks (Tg CO_2 and Percent) | Eq. 221 |
| Table 7-14: Net Changes in Yard Trimming and Food Scrap Stocks (Tg CO ₂ Eq.) | 224 |
| Table 7-15: Net Changes in Yard Trimming and Food Scrap Stocks (Tg C) | 224 |
| Table 7-16: Moisture Content (%), Carbon Storage Factor, Initial Carbon Content (%), Proportion of Initial Carbon Content (%), and Half-Life (years) for Landfilled Yard Trimmings and Food Scraps | Carbor 226 |
| Table 7-17: Carbon Stocks in Yard Trimmings and Food Scraps (Tg of C) | 227 |
| Table 8-1: Emissions from Waste (Tg CO ₂ Eq.) | 229 |
| Table 8-2: Emissions from Waste (Gg) | 229 |

| Table 8-3: CH ₄ Emissions from Landfills (Tg CO ₂ Eq.) | 230 |
|---|-------------------|
| Table 8-4: CH ₄ Emissions from Landfills (Gg) | 230 |
| Table 8-5: Quantitative Uncertainty Estimates for CH ₄ Emissions from Landfills (Tg CO ₂ Eq. and Percer | nt) 232 |
| Table 8-6: CH ₄ Emissions from Domestic and Industrial Wastewater Treatment (Tg CO ₂ Eq.) | 234 |
| Table 8-7: CH ₄ Emissions from Domestic and Industrial Wastewater Treatment (Gg) | 234 |
| Table 8-8: U.S. Population (Millions) and Wastewater BOD Produced (Gg) | 234 |
| Table 8-9: U.S. Pulp and Paper, Meat and Poultry, and Vegetables, Fruits and Juices Production (Million Tons) | Metric 235 |
| Table 8-10: Quantitative Uncertainty Estimates for CH ₄ Emissions from Wastewater Treatment (Tg CO ₂ Percent) | Eq. and 236 |
| Table 8-11: N ₂ O Emissions from Human Sewage | 237 |
| Table 8-12: U.S. Population (Millions) and Average Protein Intake (kg/Person/Year) | 238 |
| Table 8-13: Quantitative Uncertainty Estimates for N ₂ O Emissions from Human Sewage (Tg CO ₂ Eq. an | d Percent) 238 |
| Table 8-14: Emissions of NO _x , CO, and NMVOC from Waste (Gg) | 239 |
| Table 10-1: Revisions to U.S. Greenhouse Gas Emissions (Tg CO ₂ Eq.) | 244 |
| Table 10-2: Revisions to Net CO ₂ Sequestration from Land-Use Change and Forestry (Tg CO ₂ Eq.) | 245 |
| Figures | |
| Figure ES-1: U.S. Greenhouse Gas Emissions by Gas | ES-3 |
| Figure ES-2: Annual Percent Change in U.S. Greenhouse Gas Emissions | ES-4 |
| Figure ES-3: Absolute Change in U.S. Greenhouse Gas Emissions Since 1990 | ES-4 |
| Figure ES-4: 2002 Greenhouse Gas Emissions by Gas | ES-5 |
| Figure ES-5: 2002 Sources of CO ₂ | ES-7 |
| Figure ES-6: 2002 U.S. Fossil Carbon Flows (Tg CO ₂ Eq.) | ES-7 |
| Figure ES-7: 2002 U.S. Energy Consumption by Energy Source | ES-8 |
| Figure ES-8: U.S. Energy Consumption (Quadrillion Btu) | ES-8 |
| Figure ES-9: 2002 CO ₂ Emissions from Fossil Fuel Combustion by Sector and Fuel Type | ES-9 |
| Figure ES-10: 2002 End-Use Sector Emissions of CO ₂ from Fossil Fuel Combustion | ES-9 |
| Figure ES-11: 2002 Sources of CH ₄ | ES-13 |
| Figure ES-12: 2002 Sources of N ₂ O | ES-16 |
| Figure ES-13: 2002 Sources of HFCs, PFCs, and SF ₆ | ES-18 |
| Figure ES-14: Emissions Allocated to Economic Sectors | ES-21 |
| Figure ES-15: Emissions with Electricity Distributed to Economic Sectors | ES-22 |
| Figure ES-16: U.S. Greenhouse Gas Emissions Per Capita and Per Dollar of Gross Domestic Product | ES-23 |
| Figure 2-1: U.S. Greenhouse Gas Emissions by Gas | 21 |
| Figure 2-2: Annual Percent Change in U.S. Greenhouse Gas Emissions | 21 |
| Figure 2-3: Absolute Change in U.S. Greenhouse Gas Emissions Since 1990 | 21 |

| Figure 2-4: U.S. Greenhouse Gas Emissions Per Capita and Per Dollar of Gross Domestic Product | 24 |
|---|---------------|
| Figure 2-5: U.S. Greenhouse Gas Emissions by Chapter/IPCC Sector | 27 |
| Figure 2-6: Emissions Allocated to Economic Sectors | 28 |
| Figure 2-7: Emissions with Electricity Distributed to Economic Sectors | 31 |
| Figure 3-1: 2002 Energy Chapter Greenhouse Gas Sources | 37 |
| Figure 3-2: 2002 U.S. Fossil Carbon Flows (Tg CO ₂ Eq.) | 37 |
| Figure 3-3: 2002 U.S. Energy Consumption by Energy Source | 40 |
| Figure 3-4: U.S. Energy Consumption (Quadrillion Btu) | 40 |
| Figure 3-5: 2002 CO ₂ Emissions from Fossil Fuel Combustion by Sector and Fuel Type | 40 |
| Figure 3-6: Annual Deviations from Normal Heating Degree Days for the United States (1949-2002) | 41 |
| Figure 3-7: Annual Deviations from Normal Cooling Degree Days for the United States (1949-2002) | 41 |
| Figure 3-8: Aggregate Nuclear and Hydroelectric Power Plant Capacity Factors in the United States (1973-20) | 002)41 |
| Figure 3-9: 2002 End-Use Sector Emissions of CO ₂ from Fossil Fuel Combustion | 42 |
| Figure 3-10: Motor Gasoline Retail Prices (Real) | 43 |
| Figure 3-11: Motor Vehicle Fuel Efficiency | 43 |
| Figure 3-12: Industrial Production Indexes (Index 1997=100) | 45 |
| Figure 3-13: Heating Degree Days | 46 |
| Figure 3-14: Cooling Degree Days | 46 |
| Figure 3-15: Electricity Generation Retail Sales by End-Use Sector | 46 |
| Figure 3-16: U.S. Energy Consumption and Energy-Related CO ₂ Emissions Per Capita and Per Dollar GDP | 49 |
| Figure 3-17: Mobile Source CH ₄ and N ₂ O Emissions | 66 |
| Figure 4-1: 2002 Industrial Processes Chapter Greenhouse Gas Sources | 107 |
| Figure 6-1: 2002 Agriculture Chapter Greenhouse Gas Sources | 175 |
| Figure 6-2: Direct and Indirect N ₂ O Emissions from Agricultural Soils | 192 |
| Figure 7-1: Forest Sector Carbon Pools and Flows | 207 |
| Figure 7-2: Estimates of Forest Carbon Flux in Major Pools | 209 |
| Figure 7-3: Average Carbon Density in the Forest Tree Pool in the Conterminous U.S. During 2003. | 209 |
| Figure 7-4: Estimates of Forest Carbon Flux in Major Pools: Comparison of New Estimates with those in Pre- Inventory | evious 213 |
| Figure 7-5: Net Annual CO ₂ Flux, per Hectare, From Mineral Soils Under Agricultural Management, 1990-1 | 1992 218 |
| Figure 7-6: Net Annual CO ₂ Flux, per Hectare, From Mineral Soils Under Agricultural Management, 1993-2 | 2002 218 |
| Figure 7-7: Net Annual CO ₂ Flux, per Hectare, From Organic Soils Under Agricultural Management, 1990-1 | 1992 218 |
| Figure 7-8: Net Annual CO ₂ Flux, per Hectare, From Organic Soils Under Agricultural Management, 1993-2 | 2002 219 |
| Figure 8-1: 2002 Waste Chapter Greenhouse Gas Sources | 229 |

Boxes

| Box ES-1: Emissions of Ozone Depleting Substances | ES-19 |
|--|-------|
| Box ES-2: Recent Trends in Various U.S. Greenhouse Gas Emissions-Related Data | ES-22 |
| Box ES-3: Sources and Effects of Sulfur Dioxide | ES-24 |
| Box 1-1: The IPCC Third Assessment Report and Global Warming Potentials | 8 |
| Box 1-2: IPCC Good Practice Guidance | 12 |
| Box 2-1: Recent Trends in Various U.S. Greenhouse Gas Emissions-Related Data | 23 |
| Box 2-2: Methodology for Aggregating Emissions by Economic Sector | 34 |
| Box 2-3: Sources and Effects of Sulfur Dioxide | 36 |
| Box 3-1: Weather and Non-Fossil Energy Effects on CO ₂ from Fossil Fuel Combustion Trends | 40 |
| Box 3-2: Carbon Intensity of U.S. Energy Consumption | 47 |
| Box 3-3: Biogenic Emissions and Sinks of Carbon | 90 |
| Box 3-4: Formation of CO ₂ through Atmospheric CH ₄ Oxidation | 105 |
| Box 4-1: Potential Emission Estimates of HFCs, PFCs, and SF ₆ | 165 |